Remarks/Arguments

Summary

By this Amendment, Claims 16 and 24 have been revised, and accordingly, Claims 16-26 remain pending in the application.

35 U.S.C. ¶102 and ¶103

Independent claims 16 and 24, and dependent claim 26, were rejected under 35 U.S.C. ¶102 as being anticipated by Lee et al. (US 5,843,843) for the reasons stated at pages 2 and 5 of the Office Action. Applicants respectfully traverse this rejection with respect to the now-pending claims.

At page 5 of the Office Action, the Examiner states:

> *"Lee et al. disclose ... treating the exposed surface with hydrogen ... and inherently the hydrogen treatment is such that the x-ray diffraction peak half width on a crystallographic plane of a deposited metallic layer is narrowed ... wherein the metallic layer suffers a modification of its crystallographic structure wherein the metallic layer is aluminum or an aluminum alloy ..., because the same materials are treated in the same manner as in the instant invention." (Emphasis added).*

Respectfully, the Examiner is factually incorrect on two counts. First, Lee et al. does not describe a process in which the same materials are treated in the same manner as in the present invention. Second, it does not follow from the teachings of Lee et al. that the hydrogen treatment achieves a narrowing of the x-ray diffraction peak half width on a crystallographic plane of the deposited metallic layer.

The Examiner seems to rely on the assumption that the particular hydrogen treatment of Lee et al. is inevitably a disclosure of all hydrogen treatments. This clearly cannot be correct. First any process could be chemical or physical or a combination of the two. Lee et al. clearly discloses a gentle treatment in which the surface portion of the under layer is H terminated to improve wetting or to improve grain mobility. Such effects would happen at low powers and for short periods of treatment time and with zero bias voltages, and once the process was completed it would be stopped.

Such chemical processes will not survive atmospheric exposure and Lee et al. indeed teaches that his process should be run after such exposure. In contrast, the much more powerful treatment of the embodiments of the present invention will survive exposure to atmosphere, because it is indeed a different process.

The nature of the process Lee et al. is clearly stated at lines 17 to 26, column 10, and in the corresponding passage at the bottom of column 11. Lee et al. does not disclose all possible hydrogen treatments, but only those which achieve H-termination. Further, it is fundamental to the invention Lee et al. that the wearability of the surface layer is improved and this is said to give aluminum of larger grain size.

Lee et al. is a gentle treatment (low power and short treatment time), whereas the treatments of the present embodiments are conducted at much higher powers to narrow the x-ray diffraction peak half width on a crystallographic plane of the deposited metallic layer. To further clarify this distinction of the invention, claim 16 has been revised to recite that the "duration and plasma power of the hydrogen treatment are ... such that the x-ray diffraction peak half width on a crystallographic plane of the deposited aluminum nitride layer is narrowed." Claim 24 has been similarly revised. Applicants submit it to be manifest that Lee et al. does not teach or suggest the limitations of independent claims 16 and 24.

Further, claims 16 and 24 have been revised to clarify that the enhancement of the crystallographic structure is relative to a layer deposited without the hydrogen treatment of the present invention. Again, Applicants submit it to be manifest that Lee et al. does not teach or suggest this aspect of claims 16 and 24.

Lee et al. simply terminates dangling oxygen bonds and does not remove any oxides on the diffusion barrier layer. He does this to increase the mobility of the metal layer and/or the wetability between the barrier layer and the metal layer. At the bottom of column 19 Lee suggests that if these dangling bonds are terminated then the metal layer will have larger grains. This may well be right because in terminating the dangling bonds, he is removing nucleation sites, which would generally create the initial growing points for the grains and so the outcome of larger grains is quite likely. In effect, his process is analogous to greasing the surface, which is why the metal mobility and indeed the wettability is increased. However, larger grains do not mean increased orientation. Rather, the reverse seems to be true from Figures 12 and 14 of Lee where the larger grains are irregular and do not appear to pack well.

For *at least* the reasons stated above, Applicants respectfully contend that Claims 16, 24 and 26 define over the teachings of Lee et al.

The remaining claims were rejected under 35 U.S.C. ¶103 as being obvious over Lee et al. (US 5,843,843) in view of Ameen et al. (US 6143128), Roy et al. (US 6025762) or Kondo et al. (US 6001736) for the reasons stated at pages 4-5 of the Office Action. Applicants respectfully traverse these rejections for largely the same reasons as stated above in connection with the rejection under 35 U.S.C. ¶102.

Further, Applicants disagree with the Examiner's proposed modifications of Lee et al. based on Ameen et al. (inductively coupled plasma) and Kondo et al. (reactive ion etching).

Respectfully, the Examiner seems to have overlooked the objective and teachings of Lee et al. The Lee arrangement as a "soft" treatment and is based on a remote source – the electron cyclotron resonance source – and specifically this does not require either heating of the substrate or applying bias to the substrate (see lines 67 at the bottom of column 10 and line 1 of column 11). At lines 1-17 Lee explains why the use of a bias, such as in RF etching, is undesirable. In the succeeding paragraph he makes it clear that one should carry out a gentle process which simply terminates dangling oxygen bonds and does not remove any oxides on the diffusion barrier layer. He does this to increase the mobility of the metal layer and/or the wet ability between the barrier layer and the metal layer. It will be noted in the examples that the hydrogen treatment last for between ten seconds and one minute and is performed at essentially ambient temperature.

One of ordinary skill would not modify Lee et al. in the fashion suggested by the Examiner, and in fact, Lee et al. expressly teaches away from such modification.

That is, Lee et al. expressly teaches away from a high-energy and etch-like hydrogen treatment, and one of ordinary skill in the art would not adopt the ICP treatment of Ameem et al. or the RIE plasma treatment of Kondo et al. in the process of Lee et al.

Conclusion

No other issues remaining, reconsideration and favorable action upon the Claims 16-26 now-pending in the application are requested.

Respectfully submitted,

VOLENTINE FRANCOS, PLLC

By: 
Adam C. Volentine
Reg. No. 33,289

October 14, 2004

VOLENTINE FRANCOS, PLLC
12200 Sunrise Valley Drive, Suite 150
Reston, VA 20191
(703) 715-0870